building blocks

Masonry Construction…
Self-Consolidating Grout

By Jeff Greenwald, P.E. and James Farny

Reinforced masonry can be used beneficially on many types of building projects. Perhaps one drawback has been the sometimes difficult task of grouting cells, especially small/tight cores that contain heavy reinforcement. With conventional grouts this can be a slow process, and ensuring that grout spaces are properly filled requires thorough inspection plus consolidation and reconsolidation. The process can be time consuming and costly.

Supermarkets are just one of the many types of buildings that are suited to masonry construction. Tall, thin walls like the one shown here require reinforcement and grout for structural performance, but provide architectural finish without the need for further surface treatment.

New superplasticizing admixtures (polycarboxylates) have the potential to change that. These materials coat cement particles and prevent the stickiness associated with particle flocking, but don't lead to aggregate segregation. Simply stated, self-consolidating grouts (SCGs) are free flowing and cohesive, two traits necessary to fill the long, small, absorptive spaces within or between masonry units. Self-consolidating grout has the potential to revolutionize masonry construction practices. In the past, superplasticized grouts have met with limited success in masonry assemblies due to a high proportion of the limited mix water being absorbed by the units as the grout flows down the inside of the cells, resulting in premature stiffening and stoppage (or bridging) of the grout before completely filling the void. This new superplasticizer, however, has an innate ability to hold the mix water for a longer period of time before units absorb the water.

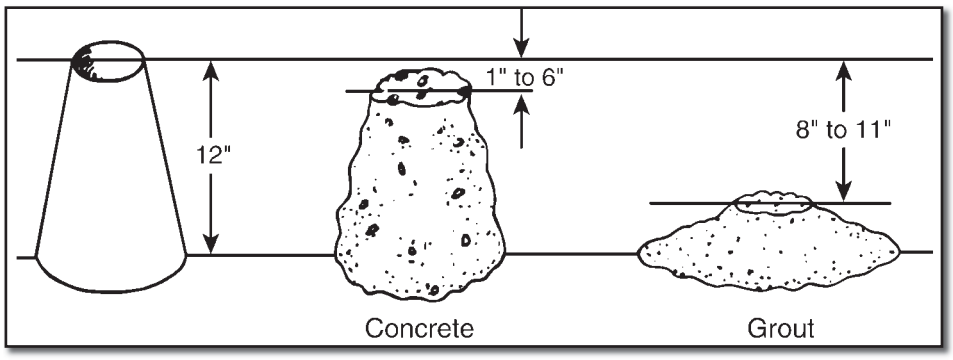
Self-consolidating grout offers potential advantages for:

1. The contractor – time and labor to place the grout is significantly reduced and the job progresses faster.
2. The ready-mixed grout supplier – his trucks are emptied in a timelier manner and can be cycled back to the plant quicker for another delivery.
3. The owner – the building is finished earlier and can be put into service sooner, reducing construction financing and earning revenue quicker.
4. The designer – better assurance that voids in the grout will be reduced in areas constricted by reinforcement and small grout spaces.
5. The masonry supplier – masonry is perceived to be a better, more competitive wall system.

Characteristics of Self-Consolidating Grouts

Grout is a fluid cementitious mixture used to bond together adjacent masonry units or wythes, to bond steel reinforcement positioned in the grout space between adjacent wythes, to bond steel reinforcement in the cores of masonry units to the masonry, or to fill reinforced bond beams. Conventional grouts contain large amounts of water to provide flowability so that the grouts can be placed. Self-consolidating grouts (SCGs) generally have lower water contents and instead contain superplasticizing admixtures to impart a high degree of workability. SCGs can be made with fine or coarse aggregates. Except for a slightly smaller coarse aggregate size (when coarse aggregate is used), SCGs are virtually the same material as self-consolidating concrete.

Removing slump cone and measuring slump spread.



Conventional grout is similar to concrete but has a greater slump (in the range of 8 to 11 inches). Self-consolidating grout, on the other hand, is so fluid that it does not remain standing after the slump cone is removed, but flows into a large pat. The pat is measured by its diameter, called a slump spread.

Specifying SCGs

Although these mixes are already well accepted in several markets—Maryland, Louisiana, Washington, Colorado, and Florida—there remain many areas where designers and contractors have never worked with or even heard of SCGs. Specifiers may be reluctant to call for them, and instead, the contractor might propose using them to save time and money. No matter which party suggests SCGs, success depends on correctly specifying important aspects of the mix.

ASTM C 476, *Standard Specification for Grout for Masonry*, allows for both proportion and strength requirements and covers conventional grout for masonry construction. With SCGs, fresh and hardened properties should be quantified. Grout

spread should be 22- to 30-inches (see "Testing SCGs" below). Grout strength should be 2000 psi minimum at 28 days, although SCG may test to 4000 psi to 5000 psi compressive strength.

Testing and Inspecting SCGs

As a check on mix design, ready mix producers will check the slump flow, called spread, before sending SCG out to a site. While currently not a requirement, checking the spread again before placing grout into the masonry wall should be conducted at the job site. To check the spread, a slump cone is filled on a stable, flat surface, then removed, resulting in a large pat of material. Pat diameter is measured at two places (at right angles to each other) and the average is recorded as the result. SCGs should have a spread of anywhere from 22 to 30 inches. At the same time, there should be no evidence of segregation: no bleed water forming around the edges of the pat and no clumps of aggregate. If either condition is occurring, it indicates non-cohesive behavior. That could lead to poor grout quality in place.

Compressive strength specimens should be made. ASTM C 1019 is the *Standard Test Method for Sampling and Testing Grout*. This standard calls for a set of grout specimens. Each specimen is molded using a "pinwheel" of sets of 4 masonry units forming a square with the height at least twice the width. The specimens are allowed to cure on the job site for at least 24 hours and then removed to the cure facility of the lab. Normally, the compressive strength of the grout is determined after curing for 28 days.

Building Code Requirements for Masonry Structures (ACI 530/ASCE 5/TMS 402) permits the use of grouting procedures that exceed the limitation on maximum pour heights, if a grout demonstration panel is constructed to verify that the proposed grouting will adequately fill the spaces. The inspecting agency should be made aware of the test panels prior to the job pour. This affords inspectors the opportunity to view the demonstration so they can compare the actual construction to it. The most important aspect of grouting will be making sure that the cells that are intended to be filled are actually filled. The grout characteristics that describe the performance of the hardened grout should have already been verified by lab testing. Specifiers can accept test results from the grout supplier.

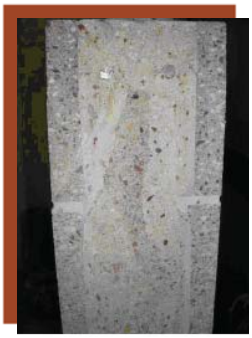
The building code requires cleanout openings to verify that cores are not obstructed with debris when grout lift heights exceed 12 feet.

Current Research Activity

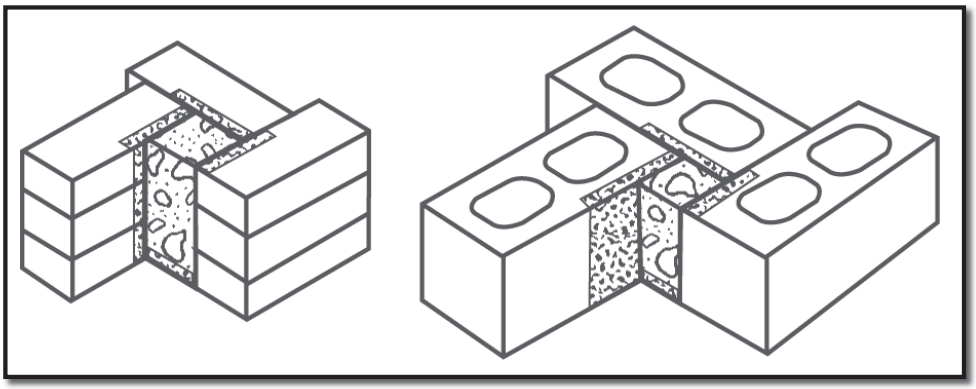
Five 12 foot, 8 inch (3.9m) tall self-consolidating grout (SCG) panels were constructed at the Research and Development Laboratory of the National Concrete Masonry Association. These wall panels are the subject of the testing and will be completely dissected for visual inspection of the grout's consistency and for possible presence of voids. Also, physical testing will be conducted to measure in-place material properties, such as compressive strength of masonry prisms as a function of wall panel height.

Included in the testing were cells in which the mortar fins were intentionally left protruding more than one-half inch into the cell area. This, in addition to two No. 5 (M #16) side-by-side horizontal bars every two feet for the full height of the wall, provided a real world test for the flowability of the SCG. It is anticipated that the SCG will completely fill the areas under these bars and all other projections without the need for mechanical consolidation. The research compares both fine and coarse SCG to conventional 9 inch (228 mm) slump, coarse grout. The effect of mechanical vibration will also be evaluated on conventional coarse grout and coarse SCG. At the time of the writing of this article, it was anticipated that the research on the 12 foot, 8 inch (3.9m) panels will be completed by the end of March 2005. Pending successful research results, code change proposals to include provisions for self-consolidating grout in masonry will be considered for the upcoming 2008 Masonry Standards Joint Committee code-change cycle. In the meantime, ASTM has already initiated material specifications for self-consolidating grout.▪

Tall masonry wall panels were built at the NCMA Labs in Herndon, Virginia, to study various aspects of self-consolidating grout, including construction and placement issues and hardened grout characteristics.



One purpose of the tall panels is to demonstrate how SCG fills less-than-ideal core spaces, such as cores containing mortar fins. SCGs are able to surround and encase mortar fins. Solidly grouted spaces are needed to develop composite action between masonry unit and reinforcement. Photo courtesy of Atkinson – Noland & Associates, Inc.



Grout molds are made from a "pinwheel" of masonry units as described in ASTM C 1019.

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